sibility that the carbon dioxide should escape, and the comparison of the first and last samples show that this is the case. The carbon dioxide in the first was 3.52 and in the last 3.55 per cent.

There is a wide variation in the per cent. of calcium and magnesium carbonates in different samples, and the positive effect of different quantities of this substance has not been ascertained. From what is known, the magnesium plays very little part in the determination of the quality of the set cement. The amount of water in the manufactured plaster seldom falls much below five per cent.; the variation being not over two per cent. when a number of analyses are compared.

Something should perhaps be said about the use of "retarders" in cement manufacture. They are especially used with the rock plasters, though occasionally, no doubt, with the cement plasters. The common opinion is that sours and sweets act as retarders, and many substances of these classes are used, such as citric acid and sorghum molasses. It is possible by the judicious use of such a retarder to delay the setting of the cement many hours, when it would normally set in a few minutes. The action of these materials seems to be to prevent the material hardening by the formation of the crystalline compound. On the other hand, there are some things that act as accelerators, and in mixing the plasters they must be rigidly excluded. For instance, if a plaster is mixed in a vessel which contained some plaster that has previously set, the setting is very much accelerated. This would very readily remind one of the production of sudden crystallization in saturated solutions by bringing into them crystals of the same material. A number of other problems in connection with the specific gravity of the material, the amount of water that should be left in the manufactured product, and similar topics, remain to be investigated.

ON THE OCCURRENCE OF NITRATES IN WELL-WATERS.

BY E. H. S. BAILEY, LAWRENCE.

Read before the Academy December 30, 1898.

It is a well-known fact that the ammonia of the air, as well as the small quantity of nitrates and nitrites therein contained, is washed into the soil by the rains, and this water there comes in contact with the organic matter of the soil, and oxidation takes place. This organic matter is first converted by the processes of decay into ammonia, and this in turn changes to nitrites and finally to nitrates, in which latter form it is available to aid in sustaining plant life.

The process of "nitrification," as it is called, may go on in surface-waters, as in ponds and streams, and is carried on very extensively in the upper layers of a loose, porous soil, where the oxygen of the air has an opportunity to assist.

This whole matter has been very extensively studied, within the past ten years, in its applications to agriculture, and also in its applications to the impurities of water and the purification of sewage. The admirable reports of the Massachusetts Board of Health, especially for 1890, on the purification of water and sewage, show the very extensive experiments which have been carried out, and the results of these researches, which have become almost classic. There has been a growing belief in the importance of "bacteria" in producing the change formerly ascribed to simple chemical oxidation. Although great difficulty has been experienced in isolating and cultivating the specific bacteria that are necessary to produce the change, yet the latest researches show that this can be done, and that water that has been sterilized can be treated with ammonia

and then sown with some of the nitrifying bacteria, which under the right conditions will change the ammonia to nitrites and nitrates.

An examination of the public water-supply of the city of Marysville, Kan., showed the presence of what we considered large quantities of nitrates, so that the matter seemed of considerable interest. The results were as follows:

Free ammonia	.075	parts per	million.
Albuminoid ammonia	.157	"	"
Nitrogen in nitrites	trace.		
Nitrogen in nitrates	9.1015	"	"

On account of the large amount of nitrogen as nitrates, and because it seemed more than would be usually found in our ground waters, some twelve more samples of water from the same city were obtained, through the kindness of the superintendent. Comparative tests on equal quantities of water were made by the use of concentrated sulfuric acid and ferrous sulfate in cold solutions; and the results were compared with those obtained with the quantitative analysis of the city supply alluded to. The results are as follows, arranging them on a scale of 1 to 4, the latter being the highest:

City water-supply, three samples: 2, 3, 2.

Wells in the same city, eleven samples: trace, $\frac{5}{10}$, 1, 1, 2, 2, 3, 3, 3, 4, 4.

It was not thought to be worth the while to make quantitative analyses of each of these wells, as the point was so well shown that the city water-supply was about the average of the wells of the city in nitrogen in the nitrates. No examination was made for nitrogen in nitrites, except in one case where only a trace was found. In this well there was found 10.6259 parts of nitrogen as nitrates, and both the free and albuminoid ammonia were a little higher than in the city supply.

It is generally held that the nitrates indicate what Frankland calls "previous sewage contamination;" and, if this is true, it is of great importance in the study of waters that are used as a source of domestic supply. It is stated that water from the drainage of cow stables has been found to contain little free or "albuminoid" ammonia, but to contain a large amount of nitrites and nitrates. Stoddart* claims that "natural waters can, at most, obtain but from 1.43 to 2.86 parts per million of nitrogen as nitrates, from other sources than animal matter; and practically the whole of the nitrogen of sewage may be oxidized into nitric acid, without diminishing the risk involved in drinking it."

Professor Mason† also quotes the results of analyses of rain-water, from various localities in Europe, as follows:

England, interior	.19	parts per	million.
England, cities	.22	"	"
Scotland, near the coast	.11	"	"
" cities	.30	"	"
" interior	.08	"	"
" Glasgow	.63	"	"
Montsouris, Paris, average of 18 years	.73	"	"

The results of some experiments made by Prof. G. H. Failyer, ‡ upon rain-water collected at the agricultural college are of interest in this connection. He reports that the different rains contained very different quantities of nitrogen in these forms:

Maximum of nitrogen as nitrates	1.850
Minimum of nitrogen as nitrates	.029

*Water-supply, Mason, p. 379.

†Loc. cit.

‡Transactions Kansas Academy of Science, vol. XII, p. 24.

To the rain-water, then, we do not look for a very large part of the nitrogen found in our ground water; much of it must come from the oxidation of the organic matter. * The effort has been made to fix arbitrarily the maximum amount that will be allowed in natural waters before they shall be considered suspicious. Some of these attempts may be of interest by way of comparison:

Elkin, dangerous if over	6.00
Vienna Commission, dangerous if over	1.04
Hanover Commission, dangerous if over	2.60
Brandes Commission, dangerous if over	7.00

Leeds' average for American rivers is 1.11 to 3.89.

The Rivers Pollution Commission (English) gives the following average from 589 unpolluted waters for nitrogen as nitrates and nitrites together:

Rain	0.03
Upland surface	0.09
Deep well	4.95
Spring	3.83

Professor Mason also quotes from the *Analyst* the following, to show the varied character of well-waters:

		Nitrogen as nitrates.
200 feet deep,	Wimbleton	0.43 parts per million.
900 " "	Southend	0.71 " "
430 " "	Braintree	0.28 " "
305 " "	Colchester	0.00 " "
600 " "	Whitham	6.43 " "
490 " "	Chatham	6.85 " "
400 " "	Norwich	11.43 " "

The above are deep wells which, as a rule, are more liable to contain nitrates than shallow wells. There is only one well in this list that contains as much nitrogen as the Marysville water, noticed above, namely, 9.10 parts per million. If this water alone contained a large amount of nitrogen as nitrates, we should be inclined to look upon it with suspicion, but an examination of the other wells in the town, some of which must have been so situated that they could not be polluted by sewage, leads to the conclusion that the *normal amount* of nitrates in the water of this locality is high. This conclusion but emphasizes the statement that has often been made by writers on water analysis, that the source of the abnormal ammonia, or nitrogen in any form, must be known before we are competent to decide on the quality of the water. If nitrates are high, we should not *necessarily* conclude that the water is contaminated by sewage, or even that it has previously been so contaminated.

A REPORT ON THE MINERAL SPRINGS AND WELLS OF KANSAS.

BY E. H. S. BAILEY, LAWRENCE.

Read before the Academy December 30, 1898.

The chemistry department at the university is still working on the waters of the state, and has some kind of a record in regard to 150 springs and wells in the state that are of a so-called mineral character. Of these we have quantitative analyses of about seventy-five, and we have quite a number still on hand to analyze. Those who have investigated the subject appreciate the difficulty of deciding as to which waters are really to be called mineral, and which are simply ordinary waters.

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* Report, National Board of Health, 1882.